Deep Artificial Networks for Evolving the Superman of Tomorrow Using Deep Meditation Techniques

A synopsis of the proposed thesis to be submitted for the degree of

Doctor of Philosophy
in
Computer Science

submitted by

Karan Narain

under the supervision of

Dr. Sandeep Paul

Supervisor
Associate Professor
Dept. of Physics & Computer Science

Prof. Huzur Saran

Co-supervisor
Professor
Computer Science & Engineering,
IIT Delhi

forwarded by

Head

Dept. of Physics and Computer Science

Dean

Faculty of Science

Department of Physics & Computer Science
Dayalbagh Educational Institute
(Deemed University)
Dayalbagh, Agra UP 282 005
December 2018

Table of Contents

Acknowledgement

1. Introduction 1

2. Literature Review 3

    2.1 Neurophysiological Datasets 3

    2.2 Neurophysiological Analysis Tools 4

    2.3 Meditation / Mindfulness 5

    2.4 Deep Learning on Neurophysiological Data 6

    2.5 Humanoid Interactions 7

    2.6 Superman 7

3. Proposed Research Objectives 8

4. Proposed Methodology 8

5. Bibliography 10

Acknowledgement

I am immensely grateful to Rev. Prof. P. S. Satsangi, for being the constant motivation and guiding force behind this study.

I am thankful to my supervisor, Dr. Sandeep Paul, and co-supervisor, Prof. Huzur Saran, for their valuable inputs and guidance.

I would like to express my gratitude to Director, DEI, Prof. P. K. Kalra, for his help throughout the effort.

Finally, I remain forever thankful to my family for their productive feedback and for being my support system.

1. Introduction

Artificial Intelligence has been a topic of academic interest for a long time now. From merely being a feature of science fiction, AI has succeeded in establishing itself as one of the most relevant technologies in modern times. Breakthroughs in computing technology have opened the doors for techniques such as Deep Learning, which were considered technologically infeasible until not very long ago[1]. From Smartphones to smart homes, smart cars to even smart clothes[2, 3], technology smarts are permeating through every aspect of daily life, with the trend seemingly in the direction of a "smart" everything.

This explosive potential has also propelled AI to the top of the most debated technologies for fears of approaching the state of singularity, when artificial super-intelligence surpasses human intelligence. Detractors have minced no words in describing the catastrophic possibilities of a future where humans become second-class citizens of the world, with super-intelligent machines reigning supreme[4, 5]. Regardless of whether such arguments are justified in their urgency or not, the apparent race to become the global leader in AI and autonomous technology raises genuine concerns of hasty offerings being made available to the public before being tested with the rigor that such technology demands. On one hand, it could be plain programmatic oversight and lack of due software diligence that inadvertently puts living beings in harm's way, but on the other hand, destructive AI behavior could actually be the very intent of its creators. Either way, the onus is on the AI developers to make sure that their offerings prioritize safety of life in all situations.

In other words, the AI would need to be programmed with some form of ethics that would prevent it from acting rogue. Toward this goal, the AI community has initiated efforts such as the Ethics and Governance of Artificial Intelligence Initiative[6], and the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems[7], that, among other functions, are meant to provide a set of ethical traits that should be coded into all AI systems. Getting everyone to agree on a set of ethical values is one part of the challenge, but the other part is to ensure that AI developers actually adhere to

coding them. After all, in order to build AI that "behaves ethically", it's creators would need to believe in those values first. On these lines, according to Rev. Prof. P. S. Satsangi, the risks posed by super-intelligent machines can be kept in check by humans possessing exemplary values and qualities[8].

In order to develop such a strong value system, ethics and moral traits would have to be deeply ingrained in the individual's personality. The human mind is most impressionable during childhood, and everything the person experiences during childhood plays a major role in forming his / her personality as well as their sense of right and wrong. It would seem logical then to instill the core values in humans right from childhood to maximize their chances of being ethical human beings and responsible individuals when they grow up[9, 10].

Such a thought process is being followed in Dayalbagh, Agra, where children enrolled in the Sant Superman scheme are nurtured and a strong value system is built in them right from the age of 3 months[11]. The term Superman in this context does not refer to Aristotle's magnanimous man or to any flying superhero, but instead to a complete human being with balanced development of body, mind and spirit. These children are being brought up in an environment that follows the Sigma Six Q Model, which prescribes certain practices for leading a sustainable way of life[12]. The way humans are brought up, and the surroundings in which they grow up are important factors in the development of the human brain.

Developmental and functional studies of the brain provide correlates of cognitive and behavioral actions of humans[13, 14]. Such studies typically use neurophysiological techniques such as Magnetoencephalography (MEG) and Electroencephalography (EEG) to capture and analyze brain activity. From a Computer Science perspective, Deep Artificial Neural Networks have also been recently employed by some researchers to process brain activity data, as such networks are capable of processing and learning complex features from large amounts of data and, in fact, perform better with more data[15-18].

Recent research suggests that meditation and mindfulness have a positive effect on brain activity[19]. Studies have been performed on various age groups, and have found meditation to be useful, especially in lowering stress levels and anxiety[20]. Eastern philosophy considers meditation as a necessary means to unlocking the full potential of the brain, and reaching higher states of consciousness[21-26].

While the importance of ethics, whether in humans or machines, is already being realized, the harder part is actually exhibiting such ethics and values. For a truly resilient value system, such qualities would have to become the natural instinct of the individual, and in a sense, would have to become part of their DNA. This sort of evolution can only be gradual, and would require that the individual be exposed to such a value system right from birth. There seems to be a lack of research work attempting to observe the effects of using meditation techniques as a facilitator in imparting such ethics to children.

A systematic and scientific study using deep artificial networks is thus proposed to understand and analyze the impact of supervised deep meditation techniques on early childhood and their role in evolving supermen of tomorrow.

2. Literature Review

The following sections cover the broad categories in which survey of existing literature was done.

2.1 Neurophysiological Datasets

Availability of public datasets helps in any deep learning application, because of the requirement of a large amount of annotated data. Some resources that can be leveraged for neurophysiological applications are covered below.

OpenNeuro [27] is a free and open platform for analyzing and sharing neuroimaging data.

Open science projects such as the International Neuroimaging Data-Sharing Initiative (INDI) of the Child Mind Institute feature an open data sharing model that has facilitated the aggregation and sharing of more than 15,000 MRI images from labs around the world. Another initiative of the Child Mind Institute is the Healthy Brain Network, which provides an open access Biobank to accelerate trans-diagnostic research and advance related areas, such as biophysical modeling, voice and speech analysis, natural viewing fMRI and EEG, and methods optimization. For researchers with limited computer skills, C-PAC is an open-source software for MRI analysis that provides automated preprocessing and analysis of resting-state fMRI data[28].

The NeuroImaging Tools and Resources Collaboratory (NITRC)[29] has an Image Repository where public datasets of DICOM and NIfTI images can be searched for and freely downloaded.

The Connectome Coordination Facility (CCF) provides public research data for a series of studies known as Human Connectome Projects, that intend to study the neural pathways underlying human brain function[30]. An extension of such projects is the Baby Connectome Project (BCP), the purpose of which is to comprehensively and systematically collect MR imaging data and behavioral assessments in healthy children between the ages of 0 and 5 years old[31].

2.2 Neurophysiological Analysis Tools

Magnetoencephalography and Electroencephalography (M/EEG) are techniques used to measure the weak electromagnetic signals generated by neuronal activity in the brain[32]. There are several tools available that take such raw brain data as input and process them to make them suitable for analysis. Some such tools are briefly described below.

MNE-Python[33] is an open-source Python software providing state-of-the-art algorithms for exploring, visualizing, and analyzing human neurophysiological data such as MEG, EEG, sEEG, ECoG,

and more. It includes modules for data input/output, preprocessing, visualization, source estimation, time-frequency analysis, connectivity analysis, machine learning, and statistics. In addition, it also provides easy access to preprocessed datasets, for helping users to get started quickly.

FieldTrip[34] is a MATLAB software toolbox offering advanced analysis methods of MEG, EEG, and invasive electrophysiological data.

Compumedics NeuroScan's Curry Neuroimaging Suite[35] and Elekta Neuromag's Data Analysis[36] software are some of the popular proprietary software tools used for analyzing neuroimaging data.

The Helsinki VideoMEG Project[37] is aimed at enabling magnetoencephalography (MEG) practitioners to record and analyze the subject's video data jointly with the acquired MEG data. It provides instructions and tools for the entire process, from hardware assembly to basic tools for the joint analysis of the MEG data with the audio-video data.

2.3 Meditation / Mindfulness

The effects of mindfulness and meditational interventions have been the subject of study in several research efforts, a few of which are summarized below.

Krisch[38] questions the methodology used in several meditational intervention studies, stating that these studies presented tenuous and unclear justifications for why a mediation intervention ought to improve prosocial outcomes, while their numeric analysis failed to find any meaningful correlation for the same.

Resnick[39] states that even though there is evidence in favor of mindfulness in terms of its positive effect on cognition and anxiety in kids, research is still unclear on specifics such as why it is so, and exactly what role is played by mindfulness instruction in the same.

Perry-Parrish et al.[20] discuss evidence that suggests that mindfulness-based interventions are beneficial for children, adolescents, and parents to enhance self-regulation and coping, which are important for management of psychological symptoms associated with stress.

Fisher[19] argues the case for meditation for children. The paper states that meditation provides a good starting point for creativity and that it is a proven means for stilling the mind, encouraging mindfulness, and providing optimum conditions for generative thinking and reflection. It mentions studies related to education that claim that meditation can improve mental abilities, health, and social behavior. It also describes some common techniques of meditation that children can follow, which involve posture, breathing, attention, and visualization. The aim of the paper seems to be to encourage more experimentation and research into meditative practice with children.

2.4 Deep Learning on Neurophysiological Data

Deep learning has recently risen in popularity, largely due to the fact that the ease of GPU hardware availability has made them more practical. In addition, several software frameworks have been built to make deep learning application development easier. Some of the most popular frameworks are Tensorflow[40], Caffe[41], PyTorch[42], and Microsoft Cognitive Toolkit[43].

Lee et al.[44] apply neural networks to develop a classification system based on meditation experience (senior, junior, novice) through analysis of the participant's EEG response during meditation practice. This classification happens according to features extracted from the changed alpha spectrum at the meditating state.

Hasasneh et al.[45] combine Deep and Convolutional Neural Networks to develop a classifier that can identify ocular and cardiac artifacts from MEG data, without needing additional Electrocardiogram (ECG) and Electrooculogram (EOG) recordings.

2.5 Humanoid Interactions

Desideri et al.[46] conducted a pilot test with children suffering from ASD (Autism Spectrum Disorder) to see if social robots can help in increasing the children's motivation as they engage in educational activities. The test used an ABA' single case design, to assess developmental and social skills such as motor and expressive / receptive language, and the outcomes from the Baseline and Post-Robotic-Intervention phases were compared. Mixed results were observed as the robot interaction seemed to enhance engagement but no significant correlation could be found between engagement and goal achievement.

Social robots such as Probo have been used as story-telling agents in exploratory investigations aimed at increasing the level of social interactions of children. Such studies have found a positive impact of the robot on interactions between therapists and children suffering from ASD, wherein children were able to perform the target behavior more easily[47].

2.6 Superman

The concept of Superman has been directly to indirectly mentioned in philosophical texts since the time of Plato and Aristotle. But the concept of Superman of Dayalbagh, Agra, is different. Revered Prof. Prem Saran Satsangi defines the new Superman of Dayalbagh in the following words:

"A complete man with balanced development of body, mind and spirit is called a Superman. He will not come into existence in a day; he will evolve gradually as the human body evolved gradually according to Darwinian principle. As is the case of the body, mind and spirit will also evolve gradually, and the spirit and mind will become so pure that a Superman will come into existence."[48]

Children from the age of 3 months can enroll in the Sant-Superman Evolutionary Scheme of Dayalbagh. They would accompany their parents in the spiritual activities at Dayalbagh, with the aim of growing

up with a strong value system so that they can spread the message of "Fatherhood of God and Brotherhood of Man"[49]. A more detailed description of the scheme can be found in the original article[50].

3. Proposed Research Objectives

It is proposed that the following objectives, or a suitable subset of the same, will be pursued.

1. To apply Deep Artificial Networks in analyzing the development of the human brain and its activity during early childhood.
2. To study the effect of supervised deep meditation techniques in the development of the human brain during early childhood
3. To study the effect of interaction between humanoids and children on early brain development
4. To assess the role of supervised deep meditation techniques in developing Superman of tomorrow.

4. Proposed Methodology

1. Important characteristics and measures indicative of children's overall development will need to be identified (eg. focus, intelligence, etc.).
2. Standard neuropsychological tests and tools to observe these characteristics will need to be chosen, or if none is found suitable, would need to be designed.
3. Tests that estimate basic values / qualities / ethics / moral traits of children would need to be explored, or if none is found suitable, would need to be designed.
4. Participants for the study would have to be chosen, and assigned to control and experimental groups.
5. The experimental group would be put on a supervised meditation schedule, wherein members of this group will be engaged in supervised meditation activities over a prolonged period of time.

6. Experiments will have to be designed where neurophysiological data is captured while the chosen neuropsychological and ethical tests are administered to the subjects (children). These experiments would need to be conducted for the same subjects periodically for a longitudinal assessment of their cognitive development.
7. For a more rigorous analysis, the neuropsychological measurements would be used to match the subjects into comparison buckets. Analysis would need to be done to check if subjects in the same bucket (similar neuropsychological performance) show any difference in their ethics evaluation if they're from the experimental group versus those from the control group, and to detect any significant differences in the activations in their neurophysiological data.
8. Deep Artificial Networks would need to be built that learn from earmarked features in the collected experimental measurements and use them for classification or prediction tasks. One example of a classification task would be to predict if a test subject shows features more similar to the control group or the experimental group. These Deep Artificial Networks can be retrained with more data as more experiments are done, and providing the longitudinal dimension of the data as an input to the network can also be explored.

If time permits, the same control and experimental groups of subjects can be used for another kind of experiment - to observe any differences in their interactions with humanoids. These humanoids could be used for assessment, where they can serve as automated administrators and validators of standard tests for children (such as motor skills, cognitive skills, language skills, etc.). This would require deployment of deep learning models on the humanoid for tasks such as perception, natural language processing, skill assessment etc. The humanoids can also be used as learners themselves, where the subjects would play the role of a teacher. Experiments for this would range from simple, such as asking the child to "teach" the AI a few words, to sophisticated, such as "teaching" the AI more complex skills such as drawing, writing, story-telling etc. Experiments could also be designed that test humanoids and children on some common parameters. The AI systems for interaction could range from standard voice-based AI systems like the Google Assistant[51], to more sophisticated humanoid robots, such as the NAO robot[52].

5. Bibliography

[1] I. Goodfellow, Y. Bengio, A. Courville, and Y. Bengio, *Deep learning*. MIT press Cambridge, 2016.

[2] H. Qiu, X. Wang, and F. Xie, "A Survey on Smart Wearables in the Application of Fitness," in Dependable, Autonomic and Secure Computing, 15th Intl Conf on Pervasive Intelligence & Computing, 3rd Intl Conf on Big Data Intelligence and Computing and Cyber Science and Technology Congress (DASC/PiCom/DataCom/CyberSciTech), 2017 IEEE 15th Intl, 2017: IEEE, pp. 303-307.

[3] M. Leighton. "7 'smart' clothing options that do everything from screen phone calls to monitor your workout." https://www.businessinsider.com/smart-clothes-with-technology-2018-4?IR=T

[4] M. Tegmark, Life 3.0: Being human in the age of artificial intelligence. Knopf, 2017.

[5] P. Holley. "Elon Musk's nightmarish warning: AI could become 'an immortal dictator from which we would never escape'."
https://www.washingtonpost.com/news/innovations/wp/2018/04/06/elon-musks-nightmarish-warning-ai-could-become-an-immortal-dictator-from-which-we-would-never-escape/?noredirect=on&utm_term=.15259300e6fb

[6] "The Ethics and Governance of Artificial Intelligence Initiative." https://aiethicsinitiative.org/

[7] "The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems." https://standards.ieee.org/industry-connections/ec/autonomous-systems.html

[8] D. P. Srivastava, V. Sahni, and P. S. Satsangi, "From n-qubit multi-particle quantum teleportation modelling to n-qudit contextuality based quantum teleportation and beyond," *International Journal of General Systems*, vol. 46, no. 4, pp. 414-435, 2017.

[9] M. S. Gazzaniga, *The ethical brain*. Dana press, 2005.

[10] J. Stiles and T. L. Jernigan, "The basics of brain development," *Neuropsychology review*, vol. 20, no. 4, pp. 327-348, 2010.

[11] B. D. Dhir. "Supermen of Dayalbagh: A Glimpse into Their Unique World." http://sigmasixq.blogspot.com/2017/08/supermen-of-dayalbagh-glimpse-into.html

[12] P. S. Satsangi. (2016) Sigma Six Q Way of Dayalbagh Life. *The Dayalbagh Herald*.

[13] B. Casey, N. Tottenham, C. Liston, and S. J. T. i. c. s. Durston, "Imaging the developing brain: what have we learned about cognitive development?," vol. 9, no. 3, pp. 104-110, 2005.

[14] M. E. Raichle and M. A. Mintun, "Brain work and brain imaging," *Annual Review of Neuroscience*, vol. 29, pp. 449-476, 2006.

[15] S. Kumar, Neural Networks - A Classroom Approach (Second Edition). McGraw-Hill Education, 2012.

[16] S. M. Plis *et al.*, "Deep learning for neuroimaging: a validation study," *Frontiers in neuroscience*, vol. 8, p. 229, 2014.

[17] Z. Akkus, A. Galimzianova, A. Hoogi, D. L. Rubin, and B. J. Erickson, "Deep learning for brain MRI segmentation: state of the art and future directions," *Journal of digital imaging*, vol. 30, no. 4, pp. 449-459, 2017.

[18] R. T. Schirrmeister *et al.*, "Deep learning with convolutional neural networks for EEG decoding and visualization," vol. 38, no. 11, pp. 5391-5420, 2017.

[19] R. Fisher, "Still thinking: The case for meditation with children," *Thinking Skills and Creativity*, vol. 1, no. 2, pp. 146-151, 2006, doi: 10.1016/j.tsc.2006.06.004.

[20] C. Perry-Parrish, N. Copeland-Linder, L. Webb, and E. M. Sibinga, "Mindfulness-Based Approaches for Children and Youth," *Current Problems in Pediatric and Adolescent Health Care*, vol. 46, no. 6, pp. 172-8, Jun 2016, doi: 10.1016/j.cppeds.2015.12.006.

[21] D. D. Price and J. J. Barrell, Inner Experience and Neuroscience Merging Both Perspectives.

[22] B. S. Misra, Discourses on Radhasoami Faith (Second Edition). Radhasoami Satsang Sabha, 2009.

[23] P. S. Satsangi, Expositions on truth, ultimate reality and supreme being (From Vantage Point of Radhasoami Faith and Systems Science) (Second Edition). Radhasoami Satsang Sabha, 2017.

[24] S. Hameroff and R. Penrose, "Consciousness in the universe: A review of the 'Orch OR'theory," *Physics of life reviews*, vol. 11, no. 1, pp. 39-78, 2014.

[25] M. Tegmark, Our Mathematical Universe: My Quest for the Ultimate Nature of Reality. New York: Penguin Books, 2014.

[26] P.S.Satsangi, S. Hameroff, V. Sahni, and P. Dua, Consciousness: Integrating Eastern and Western Perspectives. New Delhi: New Age Books, 2016.

[27] "OpenNeuro." https://openneuro.org/

[28] "Child Mind Institute: Data-Sharing and Open-Source Initiatives." https://childmind.org/data-sharing-initiatives/

[29] "NeuroImaging Tools and Resources Collaboratory (NITRC)." https://www.nitrc.org/xnat/

[30] "Human Connectome Projects." https://www.humanconnectome.org/

[31] "Baby Connectome Project." http://babyconnectomeproject.org/

[32] A. Gramfort *et al.*, "MEG and EEG data analysis with MNE-Python," (in English), Methods vol. 7, no. 267, 2013-December-26 2013, doi: 10.3389/fnins.2013.00267.

[33] "MNE-Python." https://martinos.org/mne/stable/index.html

[34] "FieldTrip Toolbox." http://www.fieldtriptoolbox.org/]

[35] "Compumedics NeuroScan's Curry Neuroimaging Suite." https://compumedicsneuroscan.com/product/curry-8-signal-processing-advanced-image-processing-source-analysis-sba/

[36] "Elekta Neuromag's Data Analysis." https://ecatalog.elekta.com/neuroscience/elekta-neuromag(R)-magnetoencephalography/products/19724/20368/22229/20231/elekta-neuromag(R)-magnetoencephalography/data-analysis/data-analysis-software.aspx

[37] A. Zhdanov, J. Nurminen, and E. J. M. Larson, "Helsinki VideoMEG Project: Augmenting magnetoencephalography with synchronized video recordings," vol. 5, pp. 234-243, 2018.

[38] J. A. Krisch. "Does Meditation Work for Kids? Does Mindfulness Make Children Better?" https://www.fatherly.com/health-science/dies-meditation-work-for-kids-mindfulness-science/

[39] B. Resnick. "Is mindfulness meditation good for kids? Here's what the science actually says." https://www.vox.com/science-and-health/2017/5/22/13768406/mindfulness-meditation-good-for-kids-evidence

[40] "Tensorflow." https://www.tensorflow.org/

[41] "Caffe." http://caffe.berkeleyvision.org/

[42] "PyTorch." https://pytorch.org/

[43] "Microsoft Cognitive Toolkit." https://www.microsoft.com/en-us/cognitive-toolkit/

[44] Y.-H. Lee *et al.*, "A cross-sectional evaluation of meditation experience on electroencephalography data by artificial neural network and support vector machine classifiers," vol. 96, no. 16, 2017.

[45] A. Hasasneh, N. Kampel, P. Sripad, N. J. Shah, and J. J. J. o. E. Dammers, "Deep Learning Approach for Automatic Classification of Ocular and Cardiac Artifacts in MEG Data," vol. 2018, 2018.

[46] L. Desideri *et al.*, "Using a Humanoid Robot as a Complement to Interventions for Children with Autism Spectrum Disorder: a Pilot Study," *Advances in Neurodevelopmental Disorders,* vol. 2, no. 3, pp. 273-285, 2018, doi: 10.1007/s41252-018-0066-4.

[47] B. Vanderborght *et al.*, "Using the social robot probo as a social story telling agent for children with ASD," vol. 13, no. 3, pp. 348-372, 2012.

[48] B. D. Dhir. "'Glory be to the Aryas'! Supermen of Dayalbagh!" http://sigmasixq.blogspot.com/2017/12/glory-be-to-aryas-supermen-of-dayalbagh.html

[49] P. S. Satsangi, "Cosmology from the twin vantage points of Radhasoami Faith and Systems Science," in *Spiritual Consciousness*, 2013, pp. 21-38.

[50] P. S. Satsangi. (2017, February 7, 2017) Sant-Superman Evolutionary Scheme in Satsang. *The Dayalbagh Herald*.

[51] "Google Assistant." https://assistant.google.com/#?modal_active=none

[52] "NAO The humanoid robot." https://www.softbankrobotics.com/emea/en/nao